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SYSTEMATIC POSITION OF REDFIELDIA (GRAMINEAE)

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In a recent paper reporting on his studies of leaf anatomy among members of the Eragrostoideae, Sutton (1973) indicated that *Redfieldia* Vasey does not belong in this group. As a result of his investigations, he concluded that this genus "should be left in the Festucoideae (tribe Festuceae) as placed by Hitchcock (1935)". Curiously, he did not note that the Grass Manual was revised in 1951 by Mrs. Agnes Chase and that in the later edition, *Redfieldia* is still retained in the Festuceae. It should also be pointed out that Vasey (1887) indicated that it appears to be related to *Festuca*.

Aside from the work of Sutton referred to above, the only other anatomical investigation of *Redfieldia* appears to be that of Decker (1964). In this latter publication the author did not discuss *Redfieldia,* but listed it in his table. Decker indicated that the genus is clearly eragrostoid in all characteristics including those observed in transections of the leaf blade. It is noteworthy that although Sutton listed the above paper in his bibiography, he did not point out that Decker's conclusions were in direct contrast to his own.

Redfieldia was described to accommodate a single species of sand-binding grass originally collected by Hall and Harbour in 1862. It had been recognized as a new species by Thurber, who in 1863 gave it the specific epithet *flexuosum* and doubtfully assigned it to *Graphephorum*

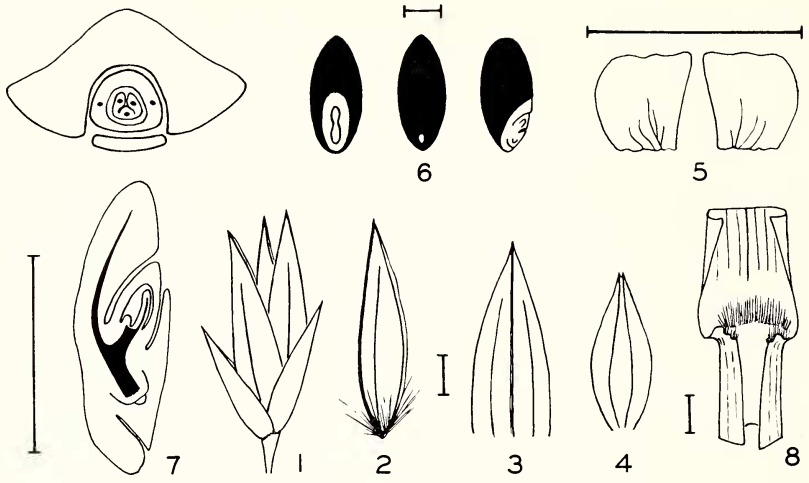
(= *Trisetum*). As indicated above, Vasey pointed out that he considered *Redfieldia* to be allied to *Festuca*. All subsequent authors who follow the traditional system have considered this grass to be a member of the Festuceae.

Apparently, the first publication in which the genus was assigned to the Eragrosteae is that of Pilger (1954); this work is essentially a key and there are no descriptions of genera. Two years later, however, Pilger (1956) gave a detailed description of *Redfieldia flexuosa* in which one finds mention of the 3-nerved lemma and caryopsis with a large embryo and small round hilum. My own investigations of the embryo indicate this same alliance. Decker (1964) had access to my unpublished information on the embryo of *Redfieldia,* but is incorrect in indicating his source as my 1957 paper. Stebbins and Crampton (1961), although making no special comments regarding the characteristics of the plant, also listed it as a member of the Eragrosteae. As already indicated, this placement was supported by the studies of Decker (1964) and has been followed in such recent works as those of Correll and Johnston (1970) and Gould (1968, 1975).

In view of the doubts raised by Sutton regarding the relationships of *Redfieldia,* along with the rather meager information in the literature concerning characteristics of this plant, a detailed study of *R. flexuosa* seems desirable. (A second species, *R. hitchcockii* A. Camus from Madagascar is little known and may not belong to the genus. See Pilger, 1956.)

Redfieldia flexuosa is characteristic of dunes of the central United States, where its ability to hold shifting sand has given rise to the common name "Blowout Grass". It has been reported from eleven states, extending from North Dakota to Texas and westward to Utah and Arizona. Although it has extensive rhizomes, the above ground portion is rather delicate, consisting of slender culms, flexuous involute blades, and a diffuse panicle. The spikelets are 2- to several-flowered, and the glumes are shorter than the lowest floret. The lemmas have three prominent nerves (figs. 1, 2, 3). The flower is typical for the family, having three stamens, a pistil with two feathery stigmas, and two lodicules. The lodicules are truncate and have vascular tissue in the lower half (fig. 5). The caryopsis has a punctate hilum and a relatively large embryo (fig. 6). Sections of the embryo (fig. 7), moreover, reveal that it is of the chloridoid-eragrostoid type, having a formula of P + PF (Reeder, 1957).

Leaves in transection, contrary to the statement of Sutton (1973), show typical chloridoid-eragrostoid structure (fig. 9). The vascular bundle is surrounded by an inner sclerenchyma sheath (endodermis) that in turn is enclosed by an outer sheath of large parenchyma cells. Outside this, the rather scanty mesophyll is arranged in a radiating pattern. Each unit of the leaf that includes a vascular bundle is separated from its neighbor by a row of large parenchyma cells (bulliform

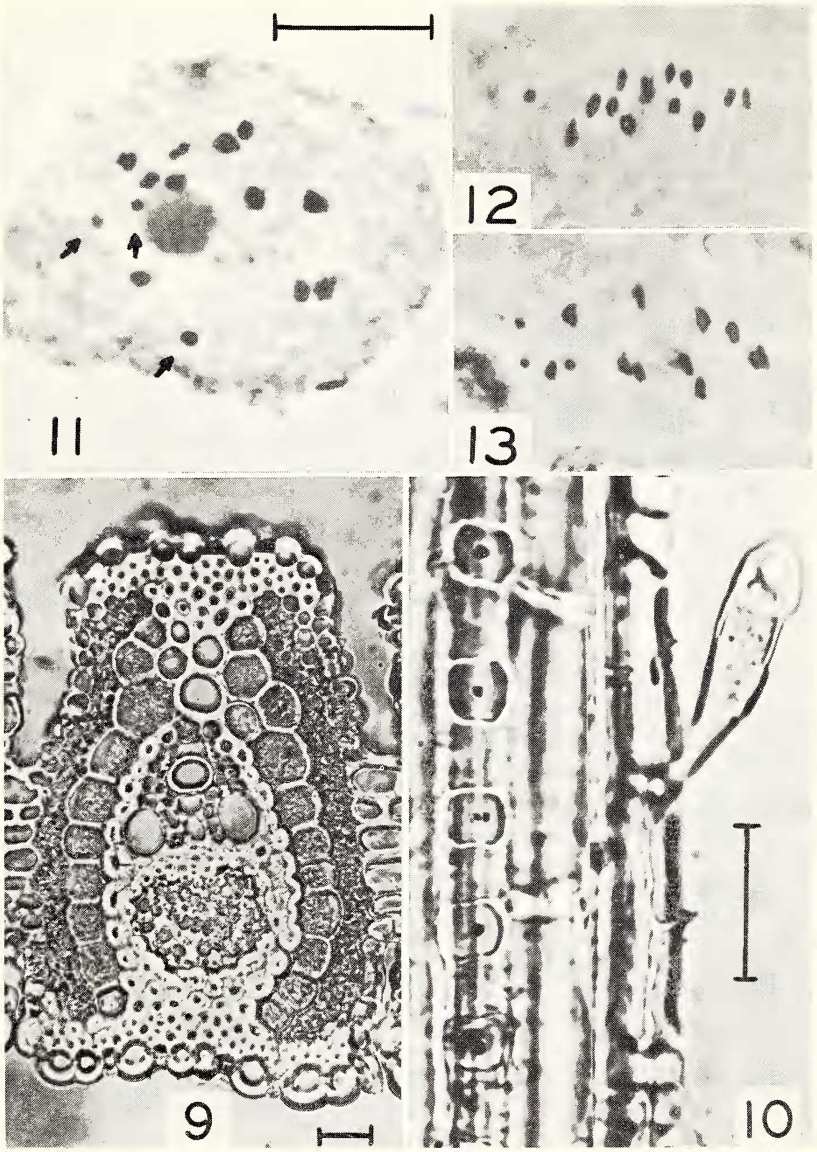


FIGS. 1–8. *Redfieldia flexuosa* (Thurb.) Vasey. 1, Spikelet. 2, Lemma in side view. 3, Lemma opened out to show the three nerves. 4, Palea. 5, Lodicules. 6, Caryopsis in three views showing the embryo and hilum. 7, Embryo in median sagittal section and in transection through the coleoptile region. 8, Ligule. Figs. 1–5 and 8, *J. R. and C. G. Reeder 5398* (RM); 6 and 7, *Rose and Fitch 17095* (US). Scale line = 1 mm.

cells), which extend from the upper to the lower epidermis. Detailed examination of the epidermis reveals two characteristics that are indisputably chloridoid-eragrostoid (fig. 10): (1) the prominent siliceous cells are saddle or double-axe-shaped, and (2) bicellular hairs are of an "ice cream cone" shape, in which the somewhat bulbous apical cell is considerably shorter than the basal one.

Finally, meiotic chromosomes are relatively small (figs. 11–13), and certainly do not at all resemble the large chromosomes characteristic of festucoid grasses. The number ($2n = 25$) is unusual. At diakinesis and metaphase I, 12 II + 1 I (fig. 12) or 11 II + 3 I (figs. 11 and 13) are present. Occasionally in this latter case, one of the bivalents is loosely synapsed. Although evidence presented here is not conclusive, I interpret this number as aneuploid and suggest that the basic number is $x = 10$. Both of my collections came from the "Sand Hills" of Nebraska, and it is possible that this material is cytologically atypical. Chromosome size, and even the number, reported here would seem to exclude *Redfieldia* from any festucoid alliance.

In summary, detailed study of *Redfieldia* indicates clearly that this genus is a member of the Chloridoid-Eragrostoid Group. It was correctly assigned to the Eragrosteae by Pilger (1954). Its eragrostoid characteristics are: lemma three-nerved (figs. 1, 2, 3), ligule ciliate (fig. 8), lodicules trucnate and with vascular traces (fig. 5), caryopsis with punctate hilum and large embryo (fig. 6), embryo with formula P + PF (fig. 7),



FIGS. 9–13. *Redfieldia flexuosa* (Thurb.) Vasey. 9, Transection of leaf through the region of a major vein showing typical chloridoid-eragrostoid anatomy. 10, Epidermis from adaxial surface of leaf blade showing saddle-shaped siliceous cells and bicellular microhair of the "ice cream cone" type. 11–13, First division of meiosis in microsporocytes. 11, Diakinesis, showing 11 II and 3 I. 12 and 13, Metaphase, showing 12 II and 1 I, and 11 II and 3 I respectively. All from collections of *J. R. and C. G. Reeder*: 9 and 10, *5398* (RM); 11, *5406* (RM); 12 and 13, *5404* (RM). Scale line = 20 μm.

chromosomes small, probably $x = 10$ (figs. 11, 12, 13), leaf epidermis with saddle-shaped siliceous cells and bicellular microhairs of the "ice cream cone" type (fig. 10), and leaf anatomy of the Kranz type (fig. 9). The statement of Sutton that the leaf anatomy is festucoid is certainly an error. Perhaps his material was from some festucoid grass mistakenly identified as *Redfieldia*. Since he cites no voucher specimens, this cannot be determined.

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DEVELOPMENT OF MORPHOLOGICAL PATTERNS IN THREE SPECIES OF DELESSERIACEAE

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Small red algae with discrete, leaf-like blades borne on short stipes are inconspicuous, but not rare, in low intertidal and subtidal habitats. In California, such blades with distinct midribs and dentate margins are usually attributed to *Nienburgia andersoniana*, if they are polystromatic. If monostromatic, they are generally referred either to *Anisocladella pacifica* or to one of three species of *Phycodrys, P. isabellae, P. profunda,* or *P. setchellii* (Abbott and Hollenberg, in press).